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European Patent Office
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⑪ Publication number:

0 009 250
A1

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EUROPEAN PATENT APPLICATION

②① Application number: 79103550.4

⑤1 Int. Cl.³: C 08 J 3/16, C 08 C 1/14

22 Date of filing: 20.09.79

③ Priority: 22.09.78 US 944681

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(43) Date of publication of application: 02.04.80
Bulletin 80/7

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⑧ Designated Contracting States: **BE DE FR GB IT LU NL**

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54 Free-flowing composite particles and method for preparing them.

57. Method for preparation of free-flowing composite particles by latex over-coagulation techniques. According to this procedure, a dispersion is initially prepared of elastomer particles. A second dispersion is also prepared containing a latex of nonelastomeric particles which have been swollen with an appropriate solvent. Both the above dispersion are thereupon combined whereby the swollen nonelastomeric particles become intimately associated with the elastomeric particles. Upon coagulation of the latex and dispersion, intimate association of the polymer particles contained therein is achieved. Recovery of the polymer particles is accomplished by filtration and the recovered particles ultimately dried. The product prepared in the above manner comprises a free-flowing mixture of (I) composite predominantly elastomer particles, (II) particles substantially devoid of nonelastomeric materials and (III) particles of nonelastomeric materials.

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TITLE MODIFIED

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METHOD FOR PREPARATION OF FREE-FLOWING COMPOSITE PARTICLES

Field of the Invention - This invention relates

5 to a method and to compositions prepared according to this method. More specifically, this invention concerns itself with the preparation of free-flowing composite particles comprising predominantly elastomeric materials. The free-flowing elastomeric materials prepared in the 10 above manner can be dry-blended with fillers and/or pigments preliminary to forming into useful shapes and articles.

Description of the Prior art - The use of flow agents in the processing and dispensing of

15 materials is a common and widely accepted practice throughout industry. The manner in which such agents function is open to various interpretations. Depending upon the material which is employed, such flow control agents can physically separate larger particles thereby
20 preventing their agglomeration or alter the surface free energy of the treated material and thereby reduce its tendency to agglomerate. Irrespective of the mechanism by which such materials operate, the fundamental purpose is the same, namely prevention of particle growth and
25 maintenance of a free-flowing particle mass.

The problem of particle agglomeration is especially acute in elastomers. Elastomer particles, "powdered rubber", are quite prone to agglomeration during storage even where such material is treated with flow control agents, such as talc. The Goodyear Tire and Rubber Company has recently introduced a powdered rubber product which is believed to comprise a polyvinyl chloride resin encapsulated elastomer particle. It is believed that fine particles of polyvinyl chloride are also present in this product as flow control agents. The manner and preparation of this product is not evident by



simple inspection of the product itself.

Where one attempts to modify the elastomer particle such as by encapsulation, care must be taken so as not to adversely alter the processing characteristics 5 of the elastomer or otherwise substantially modify its intrinsic properties. Thus, it will be appreciated that the material which is associated with the elastomer must be otherwise compatible with the end use characteristics of the elastomer and must be effective at extremely low 10 concentrations to minimize the possibility of adverse impact.

SUMMARY OF THE INVENTION

Accordingly, it is the object of this invention to remedy the above as well as related deficiencies in 15 the prior art.

More specifically, it is the principal object of this invention to provide a method for preparation of a free-flowing powdered rubber.

It is another object of this invention to 20 provide a free-flowing powdered rubber wherein the powder comprises a composite particle being composed predominantly of elastomeric materials.

It is yet another object of this invention to provide a method for the preparation of a powdered 25 rubber which comprises a mixture containing composite particles composed predominantly of elastomeric materials and minor quantities of substantially nonelastomeric materials.

The above and related objects are achieved by 30 providing a method wherein a dispersion of elastomeric particles is combined with a latex of nonelastomeric particles. Preliminary to such combination, the non-elastomeric particles are contacted with a solvent so as to result in swelling thereof. Upon the intermixing of 35 the dispersion and the latex, the nonelastomeric particles become intimately associated with the elastomeric particles. The combined system is thereupon coagulated

with conventional coagulants resulting in the deposition of at least some of the nonelastomeric particles on the elastomer. Subsequent to separation and drying, the recovered solids are evaluated for morphology and composition. It would appear that the recovered solids comprises a mixture of (i) composite particles wherein the elastomeric material is associated with the nonelastomeric material, (ii) particles of elastomeric materials substantially devoid of nonelastomeric material and (iii) fine particles of nonelastomeric materials. The fine particles of nonelastomeric material of the mixture are smaller than either of the composite particle or the particles of elastomer, and are thus believed to function in a manner similar to flow control agents. It would also appear that, in the composite particles, the nonelastomeric material has substantially encapsulated the elastomer particles. The relative concentration of nonelastomeric material to elastomeric material in such composite particles can vary within certain limits and preferably should be from about 0.5 to about 8 weight percent.

DESCRIPTION OF THE INVENTION
INCLUDING PREFERRED EMBODIMENTS

The elastomers to which this invention is particularly applicable are the vinyl acetate/ethylene copolymers containing from about 45 to about 95 weight percent vinyl acetate, polybutadienes, copolymers of butadiene with one or more monomers, such as styrene, acrylonitrile, and methylmethacrylate, and polymers of substituted butadienes such as isoprene, for example, polyisoprene, and chlorobutadiene, for example, neoprene. Most, if not all, of the above elastomers are available in the form of aqueous latices and are readily recoverable as a crumb by standard coagulation procedures. Alternatively, the above elastomers are also available in bulk and can be made suitable for use in the method of this invention by simply grinding such materials into

fine powders and dispersal thereof in a suitable fluid, such as water. The particle size of the crumbs and ground powder elastomers is not critical and will generally be about 1mm or less.

5 The nonelastomeric polymers suitable for use in the method of this invention are generally prepared in the form of a latex. Such polymers are ordinarily characterized as relatively "hard" in comparison to the elastomeric materials with which they are to be associated. Particularly preferred nonelastomeric materials which are suitable for use in the method of this invention include polyvinyl chloride, polystyrene, styrene acrylonitrile copolymers, and methylmethacrylate. As indicated above, these nonelastomeric materials are initially 10 prepared in the form of a latex. This can be achieved by emulsion polymerization of the corresponding monomers from which they are derived. As is traditionally the case, the polymerization medium used in emulsion polymerization is water. The fluid used in such emulsion polymerization and the fluid used in the dispersal of the elastomeric materials should generally be the same or 15 readily miscible within one another.

Subsequent to preparation of the latex of the nonelastomeric polymer, the polymer particles of the 20 latex are softened and/or swollen by the addition thereto of a solvent. The solvent should be immiscible with fluid component of the latex. Solvent selection is based upon its solubility parameter relative to the polymer of the latex and the elastomer. In the preferred embodiments of this invention, such solvents exhibit a high 25 solubility parameter for both such materials. The amount of solvent introduced into the latex should be in the range of from about 50 to about 150 php; and most preferably 100 php.

30 Of course, the particular solvent suitable for use in the method of this invention will depend upon a specific combination of elastomer and nonelastomeric

materials selected for use in this method. Among the solvents which have been found acceptable include methylene chloride, chloroform, 1,2-dichloroethane, chlorobenzene, chloroethane and the like.

5 Subsequent to combination of the latex and the elastomer dispersion the former is coagulated, thereby resulting in deposition of at least some of the non-elastomeric material on the elastomer particles. The extent of such deposition can vary and preferably will

10 result in substantial encapsulation of the elastomer particles. In addition to such encapsulation, the coagulation of the latex results in the formation of fine particles of nonelastomeric material. Subsequent to such coagulation, the solvent is stripped from the particulate

15 material. The solids thus produced are separated from the liquid phase by standard procedures (e.g. filtration) and dried. As indicated previously, the solid mass which is recovered is a mixture of particles; some of which being substantially elastomeric and others being sub-

20 stantially nonelastomeric. The nonelastomeric particles are smaller in size than the predominantly elastomeric particles and these smaller particles are believed to function in a fashion similar to the more traditional types of anti-caking agents.

25 As indicated previously herein, the principal object of the method of this invention is to sufficiently modify the elastomeric particles so as to prevent their agglomeration and/or compaction upon storage. The amount of nonelastomeric materials relative to the

30 elastomer particles is thus based upon obtainment of this objective. It has been found that the amount of non-elastomeric material which associates itself with elastomeric material upon coagulation of the latex is relatively concentration independent. That is, above a certain

35 relative concentration, the amount of nonelastomeric material depositing upon the elastomeric particles appears substantially the same. Similarly, the volume of

liquid present in the system does not appear to affect the overall efficiency of the method, that is, it does not apparently have any effect upon the amount of the nonelastomeric material which becomes associated with the 5 elastomer particles. Microscopic examination of the product prepared in accord with the method of this invention reveals the significant differences in the physical surface characteristics of the product when compared with the elastomer particles used in its preparation. 10 Apparently, the deposition and/or encapsulation of the elastomer with the nonelastomeric material substantially increases the specific surface area of the elastomer particle thereby improving its ease of dry blending with other common compounding agents (e.g. fillers, 15 pigments, etc.). Significant differences in surface area are also evident depending upon the method of preparation of the elastomer particle. For example, where the elastomer particles are prepared by coagulation, the powder rubber "crumb" has a substantially rougher surface 20 than elastomer particles which are prepared by physically grinding and/or pulverizing.

The only other variables which may be of significance in implementing the method of this invention relate to the temperature prevailing during such method. 25 In order to insure that the solvent is not inadvertently extracted from the nonelastomeric material prior to coagulation, the temperature of the system must be maintained below the boiling point thereof. In addition, where a coagulated elastomer is used in such method, the 30 coagulated powder rubber crumb should be washed with warm water (approximately in excess of 50°C) in order to reshape the "chips" on the surface of the rubber crumb prior to encapsulation with a nonelastomeric material. Failure to take this precautionary step prior to encapsulation can result, under certain conditions, in the 35 compaction and/or agglomeration of the elastomer upon storage. It is also advisable to allow adequate contact

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time between the dispersion of elastomer and the non-elastomeric latex to insure sufficient "wetting" of the elastomer by the nonelastomeric particles. Generally, adequate "wetting" is achieved within from about two to 5 five minutes subsequent to contact of these two materials.

THE EXAMPLES

The Examples which follow, further define, describe and illustrate the method and composition of this invention. The apparatus and techniques used in the 10 practice of this method and the evaluation of the product produced thereby are standard or as hereinbefore described. Parts and percentages appearing in such Examples are by weight unless otherwise stipulated.

EXAMPLE I

15 An acrylonitrile/butadiene copolymer (HYCAR 1052, available from The BFGoodrich Company) was first ground through a 0.64 cm screen with a micropulverizer. The ground rubber was then mixed with water and stored under agitation as a 25% solids slurry. In a separate 20 vessel, methylene chloride was poured slowly into a vinylchloride polymer latex (GEON 151, -50% solids, surface tension 42 dynes/cm - available from The BFGoodrich Company) and stirred for approximately five minutes. This solvent modified Geon latex mixture 25 was then poured with agitation into the powdered rubber slurry. After an appropriate interval approximately 1,000 gms of a 10% calcium chloride solution was gradually added through a separatory funnel to effect coagulation of the solvent modified Geon latex. This 30 metered addition of the coagulant took approximately 15 minutes. During such addition, the mixture was stirred with moderate agitation to effect coagulation of the powdered rubber. Subsequent to coagulation, the stirring of the mixture continues.

35 The temperature of the mixture was then raised to about 65°C to effect liberation of the solvent from the solvent modified Geon latex. This stripping step

took approximately 15 to 30 minutes. The interval between coagulation and stripping of the solvent is referred to as the "film forming time" and the effects of variation thereof are illustrated in Table III. Thereafter, the slurry is cooled to room temperature, the solids are separated from the fluid fraction by filtration through a cheese cloth, rinsed with water and dried at 60°C in a hot air oven. Subsequent to drying, the physical properties of the solids were evaluated. The product is a free-flowing powder. Upon storage of the solids, the fine Geon particles, which are unassociated with the elastomer, settle out and are separated from the composite particles.

EXAMPLE II

15 The procedures of Example I are repeated except at that the source of elastomer is a HYCAR latex (HYCAR 1092C50, available from The BFGoodrich Company).

One thousand grams of saturated sodium chloride solution was added to the latex at 75°C to flocculate the 20 latex. The solution was stirred for an additional 10 minutes to complete the flocculation process. The flocculated latex was thereupon coagulated at 75°C over a period of 20 minutes with zinc sulfate and magnesium sulfate dissolved in three gallons of water. The rubber 25 crumbs thus produced was separated from the fluid fraction by filtration, washed for 20 minutes with hot water (75°C) thereby reshaping the chips on the surface thereof. Subsequent to washing, the crumb is cooled to room temperature by washing in cold water, (approximately 30 20°C) and the encapsulation process repeated substantially as described in Example I.

EVALUATION PROCEDURE

Each of the products prepared in the manner of Examples I and II were evaluated in the following fashion. 35 A friability test was performed for the encapsulated rubber powder by compaction in a stainless steel cylinder (inside diameter 10.3 cm) fitted with a free moving

piston. The powder was packed in the cylinder by gravity, the piston inserted and a weight of 3 psi applied to the piston. The piston position was measured from time to time and the bulk vs density time curve plotted. At the 5 end of the compaction test, the resultant cake was taken out of the cylinder and the friability thereof determined. "Hand friable" materials indicate that the cake could be broken down to a powder by simply hand crushing and "Henschel friable" materials means that the cake 10 could be broken down by mixing in a Henschel mixer for approximately one minute. The friability of the samples was quantified by screen analysis before and after compaction testing. The tables which follow illustrate the results of such testing for samples prepared accord- 15 ing to the procedures of Examples I and II.



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TABLE I
EFFECT OF SOLVENT LEVEL ON THE ENCAPSULATION (a)

Experiment Number	Methylene Chloride (php)*	Coagulation Temperature (°C)	Encapsulating PVC (g) (g)	Powder (c) Rubber Size (mm)	Comments
213-19-8-2	50	24		1.5	
213-19-8-4	100	22		1.9	
213-19-8-5	120	28		.71	
213-19-8-1	150			1.5	
				.72	Free flowing powder
				.73	Free flowing powder
				.86	Some agglomeration on standing was observed
					10
					Solvent-PVC latex mix was very viscous.
					Free flowing powder

(a) PVC (from Geon 151 latex) 6 phr was used to coat the powder rubber and film forming time was 10 minutes.

(b) g PVC in final encapsulated powder was determined by chlorine analysis.

(c) Average powder size is defined as the size at which 50% weight of powder is smaller than.

*

php = parts by weight per one hundred parts plastic (nonelastomeric material)

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TABLE II
EFFECT OF PVC LATEX LEVEL ON THE ENCAPSULATION (a)

Experiment Number	PVC Level (phr)*	Coagulation Temperature (°C)	Encapsulating PVC (%)	Powdered Rubber Size (c) (mm)	Free Flowing Powder (?)
2113-19-8-10	4	24	1.1	.72	Yes
2113-19-8-4	6	22	1.9	.73	Yes
2113-19-8-12	8	24	1.2	.78	Yes
2113-19-8-13	10	23	1.7	.72	Yes

(a) Solvent (methylene chloride) level was kept at 100 php and film forming time was 10 minutes.

(b) % PVC in final encapsulated powder was determined by chlorine analysis.

(c) Average powder size is defined as the size at which 50% weight of powder is smaller than
 * phr = parts by weight per one hundred parts rubber (elastomeric material)

* phr = parts by weight per one hundred parts rubber (elastomeric material)

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TABLE III
ENCAPSULATION OF COAGULATED POWDER RUBBER (a)

Experiment Number	PVC Level (phr)	Coagulation Temperature (°C)	Film Forming Time (min)	Encapsulated PVC (%)	Powder Rubber Size (mm)	Portion of Total PVC as Fine Powder
213-19-15-1R	6	18	20	4.5	1.2	None
213-19-15-5	6	16	60	4.8	1.1	None
213-19-15-3R	6.5	20	20	3.1	1.5	One-half
213-19-15-4	6.5	18	60	5.1	1.5	One-quarter
213-19-15-3	8	18	10	2.2	1.4	Two-thirds
213-19-15-2R	10	15	20	3.4	1.2	Two-thirds
213-19-15-6	10	16	60	4.5	1.3	One-third

(a) One thousand grams of powder rubber was suspended in 10,000g cool water and methylene chloride was used to modified PVC latex Geon 151 at 100 ph level.

(b) % PVC in final encapsulated powder, determined by chlorine analysis.

(c) Time between adding all calcium chloride solution and start of stripping methylene chloride.

Table I clearly demonstrates the effects that variations in solvent levels can have on the ultimate product. A solvent level of 100 php seems to provide the optimum both with respect to the extent of encapsulation 5 and product properties.

In Table II, a series of samples were prepared wherein the level of polyvinyl chloride in the latex was varied. It would appear that increasing such level above 6 phr is counterproductive with respect to achieving 10 additional encapsulation of the elastomer powder. Table II clearly indicates that where such level of polyvinyl chloride in a latex is increased beyond approximately 6 phr, the excess amount of polyvinyl chloride coagulates as a fine powder which is not in any way associated with 15 the encapsulated elastomer. Table III demonstrates the effect that variation in film forming time, has on the extent of deposition. As is shown by the data, the degree of encapsulation of the elastomer powder is increased somewhat as the duration of contact, prior to 20 coagulation, is extended. Thus, it would appear that the efficiency of the encapsulation is somewhat time dependent.

The effect of polyvinyl chloride on the physical properties of the encapsulated and dusted elastomer 25 powders was evaluated and it appeared that levels of polyvinyl chloride up to about 2% do not significantly effect the viscosity of the elastomer. At levels of polyvinyl chloride of between 3.5 to about 7% the Mooney viscosity of the elastomer showed some increase however, 30 within the anticipated range. All of the changes in physical properties effected by association of the polyvinyl chloride with the elastomer were relatively insignificant and such changes could be readily compensated for by adjusting the recipe and/or the processing 35 procedures of the resultant product.

CLAIMS

1. In a method for forming free flowing, dry elastomer powder which does not agglomerate upon storage, wherein a fluid dispersion of elastomer powder and a 5 latex of nonelastomeric polymer are initially contacted with one another and the latex thereafter coagulated whereby at least some of the nonelastomeric polymer is deposited upon the elastomer powder, the improvement comprising:
 - 10 adding to the latex, in advance of its contact with the elastomer powder, from about 25 to about 150 php solvent, said solvent being substantially immiscible with the fluid phase of both the latex and the elastomer powder dispersion and having a solubility parameter
 - 15 sufficiently compatible with the solubility parameters of both the nonelastomeric polymer and the elastomer powder so as to be capable of softening both such materials.
2. The method of claim 1 wherein the elastomer powder is prepared by attrition of larger elastomer 20 particles.
3. The method of claim 1 wherein the elastomer powder is prepared by coagulation of a latex containing the elastomer.
4. The method of claim 1 wherein the powdered 25 elastomer comprises an acrylonitrile/butadiene copolymer.
5. The method of claim 1 wherein the non- elastomeric polymer comprises polyvinyl chloride.
6. The method of claim 1 wherein the solvent comprises methylene chloride.
- 30 7. The product of the method of claim 1.
8. The product of the method of claim 2.
9. The product of the method of claim 3.
10. The product of the method of claim 4.
11. The product of the method of claim 5.
- 35 12. The product of the method of claim 6.

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EUROPEAN SEARCH REPORT

Application number

EP 79 10 3550

DOCUMENTS CONSIDERED TO BE RELEVANT		CLASSIFICATION OF THE APPLICATION (Int. Cl. 2)	
Category	Citation of document with indication, where appropriate, of relevant passages*		Relevant to claim
	<p><u>FR - A - 2 179 054</u> (GOODYEAR) * Claim 1; page 3, lines 2-3 and 16-17.*</p> <p>--</p> <p><u>US - A - 3 218 278</u> (A.J. LEYDON et al.) * Claim 1 *</p> <p>-----</p>	1,3-5, 7,9-11	C 08 J 3/16 C 08 C 1/14
		1,7	-----
			TECHNICAL FIELDS SEARCHED (Int.Cl. 3)
			C 08 J 3/00 3/12 3/16 C 08 C 1/14 1/16
			CATEGORY OF CITED DOCUMENTS
			<ul style="list-style-type: none"> X: particularly relevant A: technological background O: non-written disclosure P: Intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
			<ul style="list-style-type: none"> &: member of the same patent family, corresponding document
<p><input checked="" type="checkbox"/> The present search report has been drawn up for all claims</p>			
Place of search	Date of completion of the search	Examiner	
The Hague	17-12-1979	V. HUMBEECK	

